Technology for the Far-IR Surveyor

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MKID detectors, J. Zmuidzinas

The opportunity

- Optional deliverable: identify technology gaps, due 30 June
- Goal is prioritization in Cosmic Origins Program Annual Technology Report
- Influences NASA priorities for investment through the ROSES Strategic Astrophysics Technology (SAT) program
  - Annual call
  - Next SAT proposal deadline March 17, 2017
- Annual (summer) opportunity to refine requirements and establish priorities
- Earlier investment leads to more mature technology in time for the Decadal Survey, and a more compelling case for the technical feasibility of the mission

Cosmic Origins PATR

- PATR = Program Annual Technology Report
- Last updated October 2015
- Available at http://cor.gsfc.nasa.gov/technology/
- Far-IR technology gaps on pages 33 – 40
  - Based on past far-IR mission concept studies
  - Response to community input, primarily through the Far-IR Science Interest Group (SIG), reporting to the Program Office through the Cosmic Origins Program Analysis Group (COPAG) Executive Committee
- SIG input is due on 1 June 1, STDT input on 30 June

Far-IR Technology

- **Currently recognized technology gaps:**
  - **Large-format, low-noise and ultralow noise far-IR direct detectors (TRL 3)**
  - **Heterodyne far-IR detector arrays and related technologies (TRL 2 – 4)**
  - **Large, cryogenic far-IR telescopes (TRL 3 – 5)**
  - **Far-IR interferometry (TRL 4)**
  - **High-performance, sub-Kelvin coolers (TRL 3 - 4)**
  - **Advanced cryocoolers (TRL 3 – 4)**

An example

Table 3-1. Technology Gaps Evaluated by TMB in 2015 (continued)

Name of Technology	Large-format, low-noise and ultralow noise far-infrared (FIR) direct detectors
Description	Future FIR missions require large-format detectors optimized for the very low FIR backgrounds present in space. Arrays containing thousands of pixels are needed to take full advantage of spectral information content. Arrays containing tens of thousands of pixels are needed to take full advantage of the focal plane available on a large, cryogenic telescope. Detector sensitivity is required to achieve background-limited performance, using direct (incoherent) detectors to avoid quantum-limited sensitivity.
Current State of the Art	Single detectors are at TRL ~5, but demonstrated array architectures are lagging at TRL ~3. Sensitive, fast detectors (TES bolometers, and MKIDs in small arrays) are at TRL 3 for application in an interferometric mission.
Current TRL	3
Performance Goals and Objectives	Detector format of at least 16 × 16 with high fill factor and sensitivities (noise-equivalent powers) of 10^{-19} W/√Hz are needed for photometry. Detector sensitivities with noise-equivalent powers of ≈ 3×10^{-21} W/√Hz are needed for spectroscopy, arrayable in a close-packed configuration in at least one direction. Fast detector time constant (~200 μsec) is needed for Fourier-transform spectroscopy.
Scientific, Engineering, and/or Programmatic Benefits	Sensitivity reduces observing times from many hours to a few minutes (≈ 100× faster), while array format increases areal coverage by ×10-100. Overall mapping speed can increase by factors of thousands. Sensitivity enables measurement of low-surface-brightness debris disks and proto-galaxies with an interferometer.
COR Applications and Potential Relevant Missions	FIR detector technology is an enabling aspect of all future FIR mission concepts, and is essential for future progress. This technology can improve science capability at a fixed cost much more rapidly than larger telescope sizes. This development serves Astrophysics almost exclusively (with some impact on planetary and Earth studies).
Time to Anticipated Need	Should come as early as possible since mission definition and capabilities are built around detector performance. There is a clear plan to achieve this technology. Users have been identified. To support Explorer AOs in the second half of the 2010 – 2020 decade, a focal-plane technology development + flight-testing project should be started in 2015 – 2016. This would allow time for a suborbital mission to fly in 2017 – 2020.

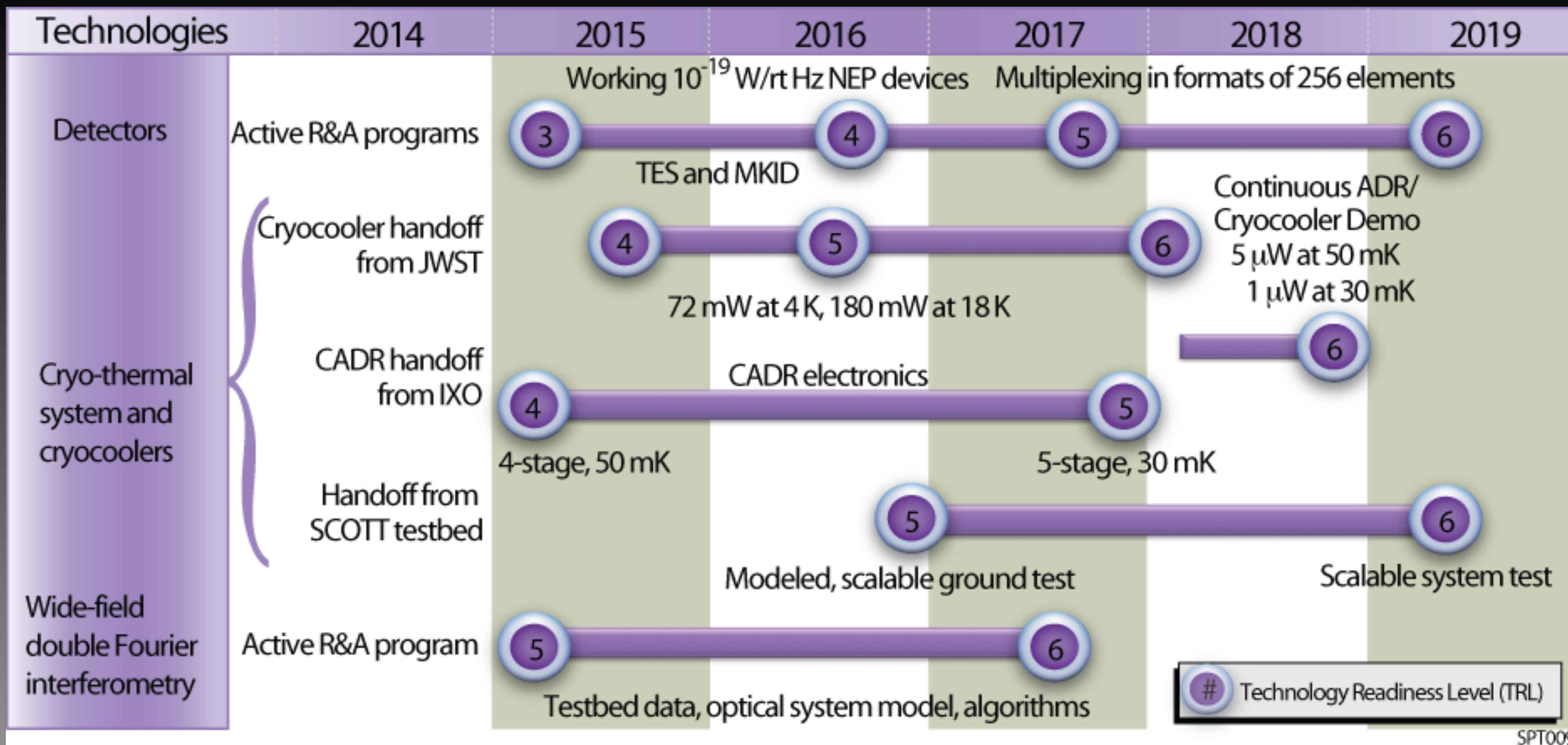
Our assignment

- Study the 2015 PATR
- Identify previously unrecognized gaps
- Update PATR narrative and TRL
- Provide input to Program Office by 30 June
- Mike DiPirro, Far-IR Surveyor Chief Technologist, will coordinate
- All STDT members are encouraged to participate
- The entire community is invited to submit recommendations to the Far-IR SIG Leadership Council

2016

Technology roadmap

EXAMPLE



- A technology roadmap is a study deliverable
- Coherent, implementable plan to mature technology to TRL 6